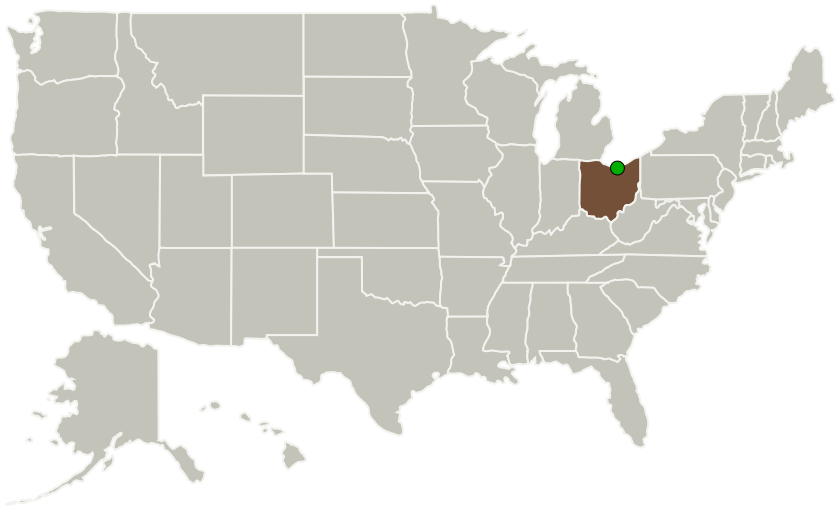
# Innovative Stirling-Cycle Cryocooler for Long Term In-Space Storage of Cryogenic Liquid Propellants, Phase I

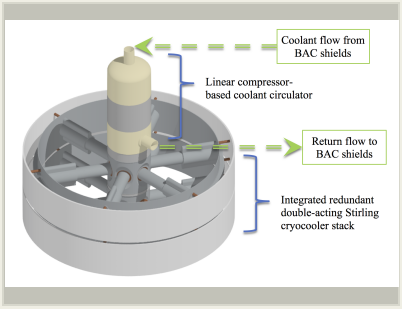
Completed Technology Project (2016 - 2016)

## Project Introduction

Numerous studies have concluded that increasing effectiveness of long-term storage of cryogenic liquid propellants, primarily LO2 and LH2, offers the largest single opportunity for reducing the mass and cost of associated space missions. The goal of this Phase I SBIR project is to evaluate and complete the preliminary design of an innovative integrated Stirling-cycle-based cryogenic refrigeration and coolant circulating subsystem for use with broad area cooling systems to deliver reduced or zero boil-off propellant storage. The Stirling cryocooler offers higher cooling efficiency than conventional reverse turbo-Brayton cooling approaches. Furthermore, the close integration of our unique open-bore cryocooler and coolant circulator reduces connecting duct length, mass and associated pumping and thermal losses and can also eliminate the need for separate coolant recuperator heat exchangers used by other cryocooler-circulator combinations. Finally, the modularity of our unique cryocooler and circulator components enables the system designer to build inherent redundancy into the system to boost propellant storage robustness over long missions. Phase I will result in a report detailing the most appropriate cryocooler, gas circulator, and integrated system configuration. The report will include projected performance characteristics for the integrated system and overall physical characteristics based on a concept layout drawing.

## Primary U.S. Work Locations and Key Partners






Innovative Stirling-Cycle Cryocooler for Long Term In-Space Storage of Cryogenic Liquid Propellants, Phase I

## Table of Contents


| | |
|---|---|
| Project Introduction | 1 |
| Primary U.S. Work Locations and Key Partners | 1 |
| Project Transitions | 2 |
| Images | 2 |
| Organizational Responsibility | 2 |
| Project Management | 2 |
| Technology Maturity (TRL) | 2 |
| Technology Areas | 3 |
| Target Destinations | 3 |

# Innovative Stirling-Cycle Cryocooler for Long Term In-Space Storage of Cryogenic Liquid Propellants, Phase I

Completed Technology Project (2016 - 2016)

| Organizations Performing Work | Role | Type | Location |
|---|---|---|---|
| Converter Source, LLC | Lead Organization | Industry | Athens, Ohio |
| Glenn Research Center(GRC) | Supporting Organization | NASA Center | Cleveland, Ohio |

| Primary U.S. Work Locations |
|---|
| Ohio |

## Project Transitions

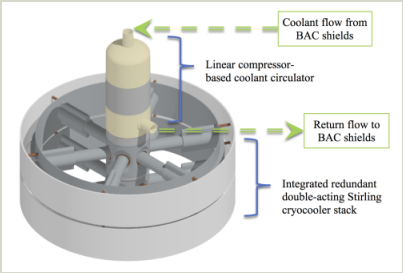
**June 2016:** Project Start

**December 2016:** Closed out

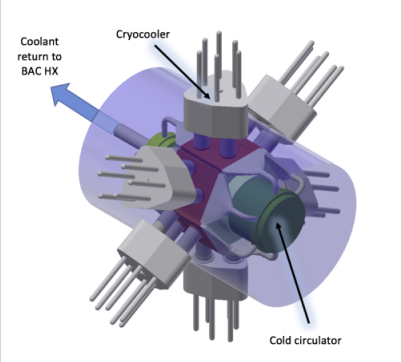
**Closeout Documentation:**

- Final Summary Chart*(https://techport.nasa.gov/file/139617)*

## Images




**Briefing Chart Image**
Innovative Stirling-Cycle Cryocooler for Long Term In-Space Storage of Cryogenic Liquid Propellants, Phase I
*(https://techport.nasa.gov/image/127757)*




**Final Summary Chart Image**
Innovative Stirling-Cycle Cryocooler for Long Term In-Space Storage of Cryogenic Liquid Propellants, Phase I Project Image
*(https://techport.nasa.gov/image/128699)*

## Organizational Responsibility

**Responsible Mission Directorate:**
Space Technology Mission Directorate (STMD)

**Lead Organization:**
Converter Source, LLC

**Responsible Program:**
Small Business Innovation Research/Small Business Tech Transfer

## Project Management

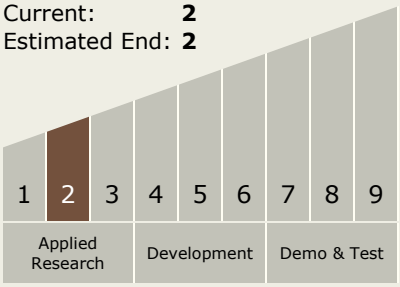
**Program Director:**
Jason L Kessler

**Program Manager:**
Carlos Torrez

**Principal Investigator:**
Lawrence B Penswick

## Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **2**



# Innovative Stirling-Cycle Cryocooler for Long Term In-Space Storage of Cryogenic Liquid Propellants, Phase I

Completed Technology Project (2016 - 2016)

## Technology Areas

**Primary:**

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.1 In-space Propellant Storage & Utilization

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System